# PATENT SPECIFICATION 693,168

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COMPLETE SPECIFICATION.

## Improved Methods of Manufacturing or Processing Lightweight Aggregates and Improvements relating to Sound and Heat Insulation.

I, GEORGE CARPENTER, of 16, Westfield Court, Portsmouth Road, Surbiton, Surrey, British, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement :—

This invention relates to an improved process of manufacturing lightweight aggregates, fillers and the like, by coating vermiculite with silicate of soda or the like together with a finely divided powdered scrap, spun or blown glass, or commercial glazing compounds or like vitreous material. Precipitated chalk or powdered limestone, borax or like gas forming materials or perlite or like expandable rock particles or fines, shale or clay may be mixed together with the glass or like vitreous materials, or added as a surface coating prior to heat treatment.

Raw vermiculite, together with the coating materials is heat treated at a temperature sufficient to exfoliate the vermiculite, as well as melt and form microscopic cavities or cells of the coating materials distributed over the surface of the vermiculite.

The method of processing or heat treating the vermiculite and coating materials would be by passing them through a rotary kiln which would be heated internally by gas, oil, powdered fuel or like method or, preferably, by movement by vibration in a tube or trough, which may be divided into sections, where the materials would be subjected to the required temperature by direct flame and/or by radiation from furnace linings. Control of the speed of the materials through the furnace, and variation of temperature would be employed to assure the right amount of microscopic cavities or cells and expansion according to the nature of the product required.

The heat treatment may be accomplished in one or more stages, and may include for a second coating with a similar vitreous material to act as binder to bond the whole into a block or slab by pressing or rolling prior to cooling. The same methods and materials may be employed using exfoliated vermiculite in place of raw vermiculite.

The processed aggregate would be used in the making of plaster or cement renderings, concretes, structural units, blocks or slabs, using the cements and binders usually employed for the type of product required. Concrete made with the processed aggregates may be used as an insulating filler with or without steel reinforcement, or a reinforcing system based on steel members encased in a strong stone or gravel structural concrete.

The coated aggregate may be used as an acoustic or sound resisting medium placed loose, or bonded lightly together to form a porous mass as may be desired, and in both cases the voids between the coated particles may be filled with sand, crushed rock or foamed slag, or the like, as a sound deadener. The bonding of the coated aggregate for this porous fill would be by silicate of soda or like flux, and the void filler include a proportion of perlite or like expandable rock which would, together with the flux and other loose material, form a fireproof mass in the event of attack by fire of sufficient severity to be dangerous to the stability of the structure.

The coated aggregate may be formed into blocks or slabs by being passed from the coating process into a secondary heated chamber at a temperature which would not affect the vesiculated coating but which would enable the mass to be pressed or rolled into blocks or slabs prior to cooling. Alternatively the coated aggregate may be recoated with a suitable vitreous binder of a lower melting point prior to being pressed or rolled into blocks or slabs. The coated aggregate may also be used as a core in the production of veneered products.

What I claim is:—

1. A method of manufacturing lightweight aggregates by coating vermiculite with silicate of soda or the like together with finely divided powdered glass, and subjecting same to heat treatment at a sufficient temperature to melt together and vesiculate the coating materials distributed over the surface of the vermiculite, which is at the same time fully exfoliated or expanded.

2. A method of manufacturing lightweight aggregates as claimed in Claim 1 which comprises adding a further finely divided gas producing material such as precipitated chalk, powdered limestone, borax or the like, to the coating materials.

3. A method of manufacturing light weight aggregates as claimed in Claims 1 and 2 but substituting commercial glazing compounds, or like vitreous material for the glass described in Claim 1.

4. A method of manufacturing light weight aggregates as claimed in Claims 1, 2 and 3, which comprises adding to the vermiculite a suitable shale, clay, or expandable volcanic rock, such as pumice or perlite, together with any of the coatings specified.

5. A method of manufacturing light weight aggregates as Claims 1, 2, 3 and 4 but substituting pre-exfoliated vermiculite for the raw vermiculite.

6. A method for producing lightweight aggregates produced as described in Claims 1, 2, 3 and 4 by passing the prepared materials through a heated zone is a rotary kiln at a sufficient temperature to accomplish the degree of vesiculation needed to expand the expandable raw material and the coating materials to the required density of the completed product.

7. A method of processing a coated lightweight aggregate of vermiculite, as described in Claims 1 to 5 inclusive, by conveying the material by means of vibration through a furnace heated by direct flame and/or by radiation from the heated furnace linings.

8. A method of processing as claimed in Claim 7 wherein the tube or trough carrying the material to be heat treated is divided into sections capable of being subjected to varied periods of vibration in order to control and maintain the required speed of flow of the material through the furnace, according to the varying weight of the material as it is expanded by the heat treatment.

9. A method of heat treatment of a coated aggregate as described in Claims 1 to 5 wherein the furnace temperature is reduced when the point of vesiculation of the vitreous coating has been reached, and the mass is held at a temperature at which the mix can be pressed or rolled into a block or slab of any required density.

10. A lightweight, acoustic, or insulating plaster or cement concrete or rendering comprising the coated aggregates produced by the methods described in Claims 1 to 8 inclusive, together with suitable cements, binders and fillers.

11. A lightweight reinforced concrete construction wherein separately constructed steel trusses, together with connectors and/or cross members are cast into a lightweight concrete mix, comprising the coated aggregate as described in Claims 1 to 8, together with a suitable cement or plaster, cast in situ, or as a separate building unit.

12. A lightweight reinforced concrete construction as claimed in Claim 11 wherein the steel reinforcement is wholly or partially encased in a heavy structural concrete prior to the lightweight concrete being cast around the supporting reinforcement, in situ or as a separate building unit.

13. A lightweight unit, block or slab as described in Claim 9 wherein a vitreous binder to melt at a lower temperature than the coating materials would be added prior to compressing the mix, reheating same if necessary.

14. A lightweight sound insulating fill comprising the coated aggregates produced by the methods described in Claims 1 to 8 inclusive, placed in position loosely, or held together by means of an adhesive, leaving voids which would be filled with sand, crushed rock or foamed slag, or like material as a sound deadener.

15. A lightweight sound insulating fill as described in Claim 14 wherein the adhesive would be silicate of soda or like fluxing material, and a proportion of the loose granular filler would be of perlite or like expandable material, so that an occurrence of fire would expand the perlite or like material and the whole of the loose filler be bonded by the fluxing material into a rigid fireproof construction.

16. A light sound insulating construction as described in Claims 14 and 15 prepared in the form of a core for use in the production of veneered sound and fireproof construction, in situ or as separate units.

17. The methods of processing lightweight aggregates, and application of same substantially as hereinbefore described.

GEORGE CARPENTER.

PROVISIONAL SPECIFICATION.

No. 3578, A.D. 1950.

# Improved Methods of Manufacturing or Processing Lightweight Aggregates and Improvements relating to Sound and Heat Insulation.

I, GEORGE CARPENTER, of 16, Westfield Court, Portsmouth Road, Surbiton, Surrey, British, do hereby declare this invention to be described in the following statement :—

New materials of light weight and high insulation value, combined with ample strength, have brought about many improvements in building practice of recent years, one of which is the use of the mineral Vermiculite which is imported from South Africa and subjected to heat treatment to exfoliate same in order to increase the bulk from ten to fifteen times. Another material which is rapidly becoming popular in the U.S.A., known as Perlite, is a natural volcanic glass which is also subjected to heat treatment to vesiculate same and so increase the bulk from five to twelve times. Both of these products have high insulation value and other valuable qualities, but differ in that Vermiculite, when exfoliated, is very soft and compressible while Perlite is of a vitreous and comparatively strong structure. There are other materials at present available having the same characteristics, more or less, but they are usually much heavier and of much lower insulation value. These include granulated and foamed slag, expanded shales, clays and the like.

I have found it practicable to manufacture or process products with a high proportion of the qualities of both Vermiculite and Perlite, using raw materials readily available in this and other countries which, while they may not compete with either of these materials for special requirements, will supply valuable bulk materials at economical cost for present-day requirements.

This invention relates to an improved process of manufacturing lightweight aggregates, fillers, earths and the like, by fusing together suitable raw materials, together with any fusing or fluxing compounds required, in a suitable furnace using the required heat and process to vesiculate the mass and/or the coating compounds, to required specification, in the form of separate particles, or in bulk which would be reduced later by crushing.

For instance a product for use as a sand or aggregate for use with cement or plaster, or for insulation or acoustic requirements, would be produced by taking a core material of crushed and graded vermiculite, or like expandable material, and coating same with materials which may include compounds designed to act as an adhesive separately or together with others which would produce a glass-like or vitreous coating, and the means for the production of gases to assist in the vesiculation of the completed product. The process would include heat treatment in a suitable furnace applied in such a manner as to have the coating in a sufficiently liquid state at the point where the vermiculite, or like material, expands and so covers the particles of the expanded material with a vitreous coating which would be brought to a state of vesiculation by the production of gases contained in the compounds included with the coating, and/or those produced during the exfoliation of the vermiculite or expansion of like materials. By varying the composition of the base, and/or the coating materials, and/or the method of heat treatment, the completed product may be finished as a strong material suitable for structural work, or a much lighter product with a foam-like structure. Particles could be formed with an outside film enclosing the cellular make-up of the particles, or may be designed to be porous.

The materials to be expanded may be prepared and mixed together in suitable form for heat treatment either in the mass or as separate particles and may be of argillaceous or clayey nature, breeze, cinder, foamed or granulated slag, gypsum, scrap glass, soda compounds, and like materials. Some of the materials, as foamed slag, would be capable of further expansion by these methods after being impregnated with a suitable flux and/or gas-forming compound.

In some cases it may be found desirable to separate the heat treatment into two or more stages, as for instance where a base material such as vermiculite would be coated with a vitreous material. In this and similar cases the furnace may be of the revolving type using tubes of different diameter. The vermiculite would be partially heated in a tube smaller than the main heating tube so that on falling from the smaller to the larger tube the coating compounds may be introduced to the partially heated and/or expanded base material by

being blown through the space formed at the junction of the tubes. Completion of the process of vesiculating the vitreous compounds would be carried out during the second stage of progression through the tubes. Other furnaces and methods may be used to accomplish the same result.

For the manufacture of structural concrete, plasters and the like these aggregates may be used together with a binder of Portland cement, gypsum plaster, aluminous cement, or adapted to refractory requirements, insulation and the like. The aggregates may also be formed into pressed or cast slabs or blocks immediately on leaving the furnace, or may be expanded in moulds during the heat treatment.

In practice these manufactured products may be mixed with a proportion of compressible material, such as exfoliated vermiculite, to prevent the breaking down of the structure of the particles when being compressed.

Heat treatment may be by any known process of direct flame, as in standard cement kilns, or, where close control of temperature is required and contact with open flame undesirable, in enclosed furnaces.

Usually the materials being treated would be travelled through zones heated as may be required either inside revolving tubes or on carriers through heated tunnels. In some instances the material to be heat treated may be moved through heated zones on metal trays or by vibration.

GEORGE CARPENTER.

## PROVISIONAL SPECIFICATION.

No. 28557 A.D. 1950.

# Improved Methods of Manufacturing or Processing Lightweight Aggregates and Improvements relating to Sound and Heat Insulation.

I, GEORGE CARPENTER, of 16, Westfield Court, Portsmouth Road, Surbiton, Surrey, British, do hereby declare this invention to be described in the following statement :—

This invention relates to improved products, methods of construction with, and application of, heat and sound insulating materials, and especially to the types of product described in my Application of Feby. 11th, 1950, relating to "Improved methods of manufacturing or processing lightweight aggregates and improvements relating to sound and heat insulation."

These improved products would be based on raw or exfoliated vermiculite coated with silicate of soda or like flux which may be diluted with water, finely powdered scrap glass, spun or blown glass, slag or like vitreous material, precipitated lime or powdered limestone, borax or like vesiculating materials, perlite or like expandable rock particles or fines which may be mixed together with the glass or like vitreous material or added after initial mixing as a surface coating.

After thorough mixing the coated vermiculite would be suitably heat treated to produce a lightweight coated aggregate suitable for use as follows :—

1. As an aggregate for use together with a binder of gypsum plaster, Portland cement, or like compounds or adhesives, which may be foamed, expanded or used together with air-entraining or waterproofing compounds, plasticisers or the like to produce strong but lightweight plain or reinforced concrete, renderings, building units or the like.

2. As a lower strength filler, similarly bonded together for use as insulation fill, or as an aggregate for the construction of walls, partitions, roofs, or building units, cast together with framed or welded steel wire, bars or shapes, sheet steel which may be formed expanded or perforated, or the like, which may also be encased wholly or partially in a high strength concrete or comparatively small sectional area to form units designed to be embedded in the weaker insulating aggregate or filler to support and reinforce same, in the form of joists, beams, or structural units, or as part of cast in situ construction.

3. As a porous sound-absorbing tile, board, block or slab construction, or lightweight core bonded as previously described and reinforced as may be required.

4. As a loose graded aggregate for use as a sound absorbing and/or resisting filler which, after being placed, may have the voids between the aggregate particles filled with sand, crushed rock particles or like material introduced by jolting or vibration.

Before placing the aggregate in position as a filler, or casting as a core it may again be coated with a suitable silicate, or like adhesive which would bind same into a more or less rigid porous filling and be set or hardened by passing cold or hot air through

the voids in the placed or cast material prior to the introduction of sand and/or rock particles intended to fill the voids.

By using a suitable proportion of the volcanic rock perlite or like expandable material, a proportion of powdered glass, spun glass or the like together with the sand, the sound-resisting filler—the value of which relies on the loose sand or rock particles together with the absorbtion value of the coated vermiculite which is retained by the added coating preventing compression of the separated laminations of the exfoliated vermiculite during mixing and placing—becomes a solid fireproof construction through the expansion of the perlite and bonding action of other materials on becoming exposed to sufficient heat as would be likely as the result of a disastrous fire.

5. As a tile, block, slab or unit bonded together by the original coating materials, to which may be added further coating or fillers required for special purposes. This type of product can be completed in one operation, exfoliating the vermiculite and coating same as previously described in a suitable furnace at the temperature needed to complete the coating, and passing the coated material to a lower temperature, at which it will retain the expanded and vesiculous state but be capable of being pressed, moulded or rolled into blocks, sheets or slabs before cooling sufficiently to set hard.

Additional material or reinforcement may be introduced at any point during this process, and it may be necessary to employ two or more operations or reheatings for special requirements.

The improvement in sound resistance by filling cavities with a porous filler and the voids in the filler with loose sand or rock particles may be applied to compound construction, such as for office or cabin partitions, by preparing the filler in the form of a core and placing between sheets of plywood, plastic sheet, sheet metal, or the like, attached to same by any suitable means.

GEORGE CARPENTER.

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